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TOWARD RELIABLE OPERATION OF MINICOMPUTER-BASED TERMINALS ON A TIP

The present protocol for communication between a TIP and attached terminals requires character-oriented transmission and provides for no error control. In the design of this protocol, it was apparently assumed that the majority of terminals attached to a TIP would be interactive, be normally used in a character-by-character mode both for transmission to and from the terminal, and normally support a human user who would in effect be in the communication loop. The human user would thus be in a position to detect any significant telecommunication-induced errors both by direct observation of the character stream and, more importantly, by examining the computer output in the context of his ongoing interaction.

The effectiveness of this means for error detection and initiation of corrective measures when necessary is not adequate in the following cases:

a. For terminal-TIP communication at a medium or higher data rate (say 1200 bps or higher) it is quite possible that the human will skim computer output and not be an effective character-by-character error detector. In particular, when both user input and computer output contain numerical data it is possible that significant undetected errors could occur.

b. For terminals located at a distance from the TIP and connected either by a private line or the switched network more errors may be introduced than with a terminal local to the TIP (see Note 1). When a large number of user terminals are connected to TIP's through telecommunications facilities, whether within a single organization or, even more likely, when users and user groups not needing the full TIP capability are connected to a remote TIP, this problem may arise.

c. For terminals containing a substantial amount of logic, including possibly a minicomputer, a human user is very likely not in the direct terminal-TIP communications loop. This case is important, since both alphanumeric and full graphics terminals containing minis are now becoming popular.

d. An interesting potential application of the network is to provide support for minicomputers used for process control and other laboratory measurement functions. In providing software support for such minis as well as acquiring data from them usually there is no human user in the communication loop.

e. A number of sites already offer a remote job entry service. Although the present sites assume that the unit record devices such as card readers and line printers are files within a multiprogrammed system at another site, it appears natural that remote batch terminals be attached to the network through TIP's. Here again, there would be no human in the loop between the terminal and the TIP.

In addition to some degree of error control on these types of terminal loops, it may be desirable to provide for block-oriented data transmission, at least for terminals of types (d) and (e) and possibly (c) above. It is possible that error control utilizing block transmission can be superimposed on the present TIP-terminal communication protocol. Data blocks, including error control and block delimiting information, can be multiples of a single character in length. The communication channel would still not be as fully utilized as for conventional synchronous block communication, since start and stop bits for each character would need to be transmitted. This loss is not substantial and does occur now for 2000 bps TIP-terminal communication.

There are at least two ways to implement such a protocol on top of the existing TIP-terminal communication protocol. In both cases, the remote terminal would have to handle both originate and receive error and block control procedures:

a. Through an addition to TIP software, the controlled communication loop could terminate in the TIP, thus providing error control only where it is most needed, between the TIP and the terminal. This, however, would involve additional TIP software and a block buffering capability which may put an excessive load on the TIP.

b. The other end of the block transmission error control loop could be in the serving host system, either in an applications program or in system support software.

If the remote end of the block transmission error control loop is in the serving host, then this software could possibly be used for host-to-host, end-to-end error control in addition to host-host-terminal end-to-end error control. For host-to-host communication, however, there would be a slight loss in efficiency due to the imbedded character-oriented format, unless an option were provided in which start/stop bits were not required.

Note 1: The most recent published data concerning data transmission error performance of the switched telecommunications network is provided in the 1969-70 Connection Survey conducted by Bell Laboratories. The results are published in The Bell System Technical Journal, Vol. 4, No. 50, April 1971. In this survey, 12 receiving and 92 transmitting sites in the U.S. and Canada were used with standard Bell System Dataphone datasets used at both ends. At both 1200 and 2000 bps, approximately 82% of the calls had error rates of 1 error in 10^5 bits or better, assuming an equal number of short, medium, and long hauls.

The results of this survey for low-speed, start/stop data transmission at rates up to 300 bps indicate a character error rate of 1 error in 10^4 characters or better on 77.6% of all calls made within the survey. It is interesting to note that only 48.3% of the low-speed data tests completed were error-free. These tests were nominally 40 minutes in length.

For voice grade private line data channels, the Bell System technical reference, "Transmission Specifications for Voice Grade Private Line Data Channels," dated March 1969 reports "When a Bell System dataset is combined with the recommended channel, the expected long term average error rate of the system is 1 error in 10^5 bits or better during normal transmission conditions."